DEPARTMENT OF DEFENCE
DEFENCE SCIENCE & TECHNOLOGY ORGANISATION
DSTO

Towards a Research Methodology for Assessing Army Command Team Performance: A Preliminary Examination

Vanessa Mills and
Christina Stothard

DSTO-TR-1034

Towards a Research Methodology for Assessing Army Command Team Performance: A Preliminary Examination

Vanessa Mills and Christina Stothard

Land Operations Division
Electronics and Surveillance Research Laboratory

DSTO-TR-1034

ABSTRACT

This report presents a summary of observational methodologies that are being developed to collect behavioural data on team processes in an Army Headquarters (HQ). The report will describe this approach, and will present a sample of data that can be generated using these methods. The techniques are currently being applied to observations within the Australian Army to determine their usefulness, and to collect empirical data on the information flow among the team, the team dynamics, the task characteristics, and the overall workload. A strength of this approach is that it can be applied at any level of HQ, and at different intensities and tempos. It also provides indices of performance that can be correlated with other outcome measures, as well as implications for system design based on functional accounts of behaviour.

RELEASE LIMITATION

Approved for public release

DEPARTMENT OF DEFENCE
DEFENCE SCIENCE & TECHNOLOGY ORGANISATION
DSTO

Published by

DSTO Electronics and Surveillance Research Laboratory
PO Box 1500
Salisbury South Australia 5108 Australia

Telephone: (08) 8259 5555
Fax: (08) 8259 6567

AR-011-554
September 2000

APPROVED FOR PUBLIC RELEASE

Towards a Research Methodology for Assessing Army Command Team Performance: A Preliminary Examination

Executive Summary

Military command teams are currently being provided with digital support tools that automate information management processes and provide access to an increased level of information. The introduction of these systems into what was a manual process has the potential for significant impact on team processes. Research on aviation and naval command team performance suggests that not all aspects of digitisation improve performance. This creates a requirement for the development of techniques that identify and delineate the teamwork and the taskwork processes in Army Command and Control. Taskwork consists of behaviours that are performed by team members and are critical to the execution of team member functions. Teamwork, in contrast, consists of behaviours that are related to team member interactions, and are necessary to establish coordination among the team members to achieve goals.

This report presents observational methodologies that are being developed to collect behavioural data on team processes in Army HQ. This report describes this approach, and presents a sample of data that can be generated using these methods. The techniques have been applied to observations within the Australian Army to determine their usefulness, and to collect empirical data on the information flow among the team, the team dynamics, the task characteristics, and the overall workload. A strength of this approach is that it can be applied at any level of HQ, and at different intensities and tempos. It also provides indices of performance that can be correlated with other outcome measures, as well as implications for decision support system design based on functional accounts of behaviour.

Authors

Vanessa Mills
Land Operations Division

Vanessa Mills graduated from the University of Adelaide in 1994 with a Bachelor of Arts degree and Honours in Psychology. Vanessa has since worked at the University of Adelaide, Department of Psychology, lecturing in the areas of Learning, Environmental Psychology, and Animal Behaviour. She completed her PhD in 1998, and in 1999 joined the Department of Defence. Vanessa is currently involved with the Optimising C4ISR Systems Integration Task. She is also involved with collaborative research on naturalistic decision making at the Department of Psychology, University of Adelaide. Vanessa is employed as a Research Scientist within the Human Systems Integration discipline.

Christina Stothard
Land Operations Division

Christina Stothard graduated from the University of Adelaide in 1991 with a Bachelor of Arts degree and Honours in Psychology. Christina has since worked at the University of Adelaide at the Departments of Community Medicine, Clinical and Experimental Pharmacology and Psychiatry, as well as the University of South Australia in the School of Social Science. In 1998 Christina joined the Department of Defence and has had a key role in developing performance measures of operational Army headquarters, and reviewing the problems of introducing digital systems into a workplace. As part of the C2 team evaluating the operation of the BCSS in the Army she has interviewed 1 Brigade (Darwin), 7 Brigade (Brisbane) and 9 Brigade (Adelaide). Christina is currently employed as a Professional Officer with the Human Systems Integration discipline, and tasked to Optimising C4ISR Systems Integration Task.

Contents

GLOSSARY

2IC	Second in Command
ACTA	Applied Cognitive Task Analysis
AO	Area of Operations
BCSS	Battlefield Command Support System
Bde HQ	Brigade Headquarters
Bn HQ	Battalion Headquarters
Bn CP	Battalion Command Post
CHQ	Company Headquarters
C2	Command and Control
CO	Commanding Officer
Ex RC00	Exercise Rhino Charge 2000
HQ	Headquarters
INT	Intelligence Cell
KSA	knowledge, skills, and attitude
LO	Liaison Officers
LOG	Logistics
MAP	Military Appreciation Process
OPS	Operations
SMM	Shared Mental Model
TADMUS	Tactical Decision Making Under Stress project
TLX	Task Load Index
TPOM	Team Performance Outcome Measure

1. Introduction

1.1 Human Factors Problems In Military Command Teams

Over recent years, there has been an increasing focus on the human component of military Command and Control (C2). A variety of tragedies have demonstrated that one of the largest influences on system performance is the human factor. Human error has been found to be responsible for 60% to 80% of fatal aviation accidents, and communication issues were found to be involved in more than 70% of accidents (Brannick, Prince, Prince & Salas, 1995). The suggestion is that a large influence on effective performance is the way humans interact with each other. Thus, a critical determinant of performance is the team behaviour.

Nowhere was this influence seen so strongly as in the USS Vincennes incident. In 1988, the Commanding Officer (CO) of the Vincennes fired two SM-2 missiles at a civilian Iranian airbus leaving no survivors (Gregory & Kelly, 1998). The CO made his decision to engage based on information he received from crew members in the Combat Information Centre (Klein, 1993). What is noteworthy is that all equipment on the Vincennes (except the forward gun) worked impeccably throughout the incident. Likewise, the information needed to prevent the tragedy was readily available to the crew.

This incident sparked a congressionally mandated research project, and it has been suggested that the dynamics of the command team were the cause of the tragedy. In particular, the extent to which the team dynamics influenced the interpretation of the available information was considered to be the critical factor. This information included the fact that the team was under pressure to avoid the fate of the USS Stark (in 1987, two Iraqi Exocet missiles hit the Stark, killing 37 crew). In addition, the ship was under surface attack when the Airbus appeared on radar. These data were used to support the team's expectancy at the expense of ignoring contrary evidence (Gregory & Kelly, 1998).

This suggests that the human interpretation of the data on the USS Vincennes was a greater determinant of decision making than the data alone. The U.S. Government considered the human factor to be so crucial, they funded the Tactical Decision Making Under Stress project (TADMUS). This project started in 1990 and was still continuing in 1999. It was an interdisciplinary program involving the development of both training and human factor technologies (Collyer & Malecki, 1998). The aim was to enhance the quality of tactical decision making, particularly in relation to the effect of information presentation on military teams. This project is just one example of the fact that team performance is considered to be of such importance that the U.S. military invests more in team research than any other entity (Cannon-Bowers & Salas, 1998).

1.2 Towards a Research Methodology in Army C2

Despite this focus in the U.S., there has been a relatively low level of empirical research on C2 team performance in an Australian context. However, the Australian Army is currently introducing information technology to C2 operations by installing Battlefield Command Support Systems (BCSS) into the numerous Brigades (Bde). As

a consequence, there is a high degree of urgency in developing an increased understanding of this domain. The introduction of digitised systems into what has previously been a completely manual process has the potential for significant impact. Research in the U.S. and the U.K. has already shown that assumptions that digitisation will improve performance may be faulty. For example, a study by Bowers, Thornton, Braun, Morgan, and Salas (1998) found that automating certain tasks was associated with improved system performance on only 1 in 4 measures.

Given the increasing emphasis on digital systems, it is important that research be conducted that will assess the impact on the performance of the C2 team. To date, Human Factors research on the effectiveness of BCSS has attempted to assess the impact of digitisation by asking the user what they think of the system. As noted by Klein (1993), a common mistake that system developers make is to ask users about the effectiveness of the system, without conducting empirical evaluation. While a great deal of insight may be gleaned from such a process (eg. attitudes to the system), it does not provide information on actual team performance. An alternative approach is for analysts to examine the impact of the system on the performance of the team.

In summary, a consequence of the introduction of digitised systems, and of the minimal empirical research to date, is a requirement for research that investigates and establishes techniques for analysing team tasks. In particular, techniques are required to identify and delineate the teamwork knowledge, skills, and attitudes (KSAs). In addition, there is also a need for research on team cognition. As noted by Cannon-Bowers and Salas (1998), the increase in information technology and consequent increase in tasks with high cognitive demands, means that shared knowledge will become an ever-increasing critical factor in team performance. An aim of the current report is to refine potential methodologies that can be used to examine the impact of digitised command support tools on Army C2 teams. In particular, there will be a focus on adapting research methodologies developed by TADMUS researchers for use with Australian Army C2. The advantage of these methods is that they are already standardised, and have clearly demonstrated reliability and validity.

1.3 Defining the Team Performance

In order to determine what data collection techniques we should be using, it is important to clarify what is meant by team performance. Two categories of behaviour can be distinguished in a team: a taskwork track and a teamwork track (Gregory & Kelly, 1998). Taskwork consists of behaviours that are performed by team members, and are critical to the execution of team member functions. Teamwork, in contrast, consists of behaviours that are related to team member interactions, and are necessary to establish coordination among the team members to achieve team goals (Salas, Prince, Baker, & Shrestha, 1995). McIntyre and Salas (1995) define taskwork as the "technical aspects of the team operations" and teamwork as "all the interactive behaviours among the team members".

These two aspects of working within a team are influenced by different factors, yet both contribute to effective performance. Research has shown that while individual competency is necessary, it is not sufficient for successful team performance (Stout,

Salas & Carson, 1994). These findings point to the importance of evaluating the team interactions that occur, as well as assessing an individual's ability to do their job.

What must also be kept in mind is the primary task of the C2 team: That is, to assist the commander in the decision making process (Orasanu & Salas, 1993). While battle command responsibility is focused on the commander, command itself is a process conducted by an organisation (Leedom, 1999). In other words, the HQ is composed of a distributed decision making team, and is part of a complex sociotechnical system (Vicente, 1999). Thus, to assess command system performance and effectiveness, it is necessary to understand it as an organisational process that involves the complex interaction of cognitive, technological, and social factors (Leedom, 1999). In addition, because military teams operate in a complex and dynamic environment, a host of other factors influence the quality of behaviour and performance (eg. ambiguous goals and information, high time and risk states, and unstructured problems) (Pascual, 1999). A consequence is that in such a complex system, there is no one definitive method of assessing HQ performance. Each approach assesses one particular aspect of the HQ operation. For example, results of wargame simulations assess overall task effectiveness but do not provide insight as to information requirements within the HQ. Hence, multiple measures need to be used to build up a picture of the overall performance. A composite approach to evaluating HQ is required.

The measures used to evaluate performance also need to be grounded in the aim of the investigation. That is, the aims of the research underpin the measures used to establish it. For example, a training needs analysis requires different information compared to an individual skills examination.

There are several different methods of measuring both taskwork and teamwork. These include:

- Objective methods: These are used to collect empirical data on the information flow among the team, the team dynamics, and the task characteristics. Observational techniques, such as behavioural and task load checklists, are used to formalise the process of data collection.
- Subjective methods: These provide the individual's perceptions of teamwork and task characteristics, using questionnaires and structured interviews. This type of data provides useful insights into the individual's perception of changes to their environment (eg. the introduction of BCSS). It is also useful for identifying possible barriers to introducing changes to the system.
- Outcome measures: These include results of wargame simulations (eg. the number of enemy, friendly and civilian casualties, time taken to complete the mission, etc). They provide an objective measure of performance that can be empirically linked to the observations and subjective data.

1.4 Observational Methods

The development of objective observational techniques that can be used to collect data on team and task behaviour is the main focus of this report. To date, behavioural observations conducted by DSTO analysts have tended to be informal. For example, analysts observe an exercise, making informal notes of what are

believed to be the salient characteristics. This approach has strong value in generating insights and lessons learned. However, it does not allow the collection of formal data on team processes after the introduction of systems such as BCSS. More importantly, informal observation does not provide implications for design principles that can be incorporated into future systems.

In contrast to this approach (and to the collection of subjective data via the use of such methods as questionnaires, Structured Interviews and After Action Reviews), formally observing and categorising behaviour allows analysis of what is happening and in what sequence. Observing provides information on what actually happens rather than relying on the subject's perception of what was occurring. This is an important distinction when the aim is to examine team processes and inform future design processes for command support tools. While an individual's subjective experience does impact on their performance, and should be taken into account, to assess the team as objectively as possible, it is necessary to observe it in operation.

Categorisation of observed behaviours needs to be made explicit when using this method (see Section 3 for a detailed description of methods involved in formally collecting behavioural data). The categorisations or rating scales should allow the observer, after suitable training, to reliably score behaviour. This is an important step. The reliability of a rating scale can be calculated by comparing the degree of correlation across independent observers using the same scale on the same event. A high degree of correlation between the independent observers shows that the scale can be used to generate reliable information.

Smith-Jentsch, Johnston and Payne (1998) developed reliable and diagnostic ratings of critical team processes. They advocate an event-based approach to obtaining measures of individual and team processes that can be empirically linked to important outcomes. Their research was conducted as part of the TADMUS project, and defined four factors that were highly correlated with performance:

- Communication (how information is exchanged),
- Information Transfer (what information is exchanged),
- Team Supportive Behaviours (how the team interacts)
- Team Initiative (defining goals and roles)

In a similar study by Serfaty, Entin and Deckert (1994), 73% of the variance was accounted for by the Team Performance Outcome Measure (TPOM). Likewise, Serfaty and Entin (1997), using a teamwork observational form, found that 15 behaviourally anchored items across 6 dimensions accounted for 86% of variance in performance. In summary, these results suggest that to understand and subsequently enhance command performance, one must focus on the team behaviour.

1.5 Towards a Predictive Model of Performance: The Behaviour Systems Approach

It should also be noted that this report is part of a longer-term research project that aims to develop a theoretical framework for predicting performance in C2. The Behaviour Systems approach adopts an ecological framework and has the advantage of embedding behaviour within a complex system. When dealing with a complex

sociotechnical system such as an Army HQ, such an approach is vital in ensuring valid conclusions are drawn.

It is beyond the scope of this report to provide a detailed overview of the Behaviour Systems approach. Instead, the following information is provided to give the reader a general sense of the approach, while the reader is referred to Timberlake (1998) for greater detail.

By adopting an ecological framework, the analyst seeks to set performance within the functional context in which it resides. The approach assumes that the subject comes equipped with organised stimulus sensitivities, processing capacities, response structures and integrative states that are designed to produce adaptive behaviour in particular environments. Learning and changes in behaviour occur as modifications in the operation, inclusion and linkage of different mechanisms. An ecological analysis of behaviour considers how, where and to what end the operation of a functioning system is modified by experience. The subject must interpret the altered environmental stimuli within an evolved and developed functional framework.

The Behaviour Systems approach attempts to formalise this process into a predictive model. A more developed model incorporates data from behavioural observations, physiological characteristics, and experimental manipulations. To begin with, however, the analyst should focus on developing a baseline of the structure and processes of the system. In fact, to be able to generate predictions, it is necessary to have a baseline model of the functioning system. Timberlake (1998) describes the following steps in developing a predictive model of behaviour:

1. Pose a question about how the subject works in a functional context. For example, what are the mechanisms involved in the decision making process of the CO of a Battalion HQ?
2. Assemble behavioural observations into a preliminary model of the structure and processes that the subject brings to the relevant situation. The purpose of this model is to provide information about the initial characteristics that the subject brings to the circumstances under consideration. This model is unlikely to be perfect, but it is necessary to start with a model of appropriate complexity that allows analysis and testing in multiple ways. A simple model can limit consideration of potentially important determinants, while starting off at too complex a level can make analysis impossible.
3. The third step is to integrate the observations into an initial causal behaviour system.
4. Step four involves designing an experiment to clarify/test a prediction of the simple causal system. For example, what effect does "X" have on the decision making process of the CO? Rather than having to engage the entire system, such a prediction can be tested in a micro-world simulation of C2, such as Networked Fire Chief (Thomas, 1999), or the Tactical Land C4I Assessment Capability (TLCAC) (Bowden, Gaertner & Williams, 2000).
5. The fifth step is to interpret the outcome of the experiment as the result of the interaction of the pre-existing causal system with the experimental environment, rather than as a simple result of the independent variable.

6. The sixth step is an attempt to store the results of the manipulations in the form of additions or corrections to the model.

These stages need to be repeated until the model is demonstrated to have reliability and validity. Once this has occurred, it can be employed to guide such areas as system design and processes for training. The advantage, as was mentioned, is that it grounds predictions in an ecologically valid framework.

2. Aims and Objectives

As was mentioned, one aim of this report is to refine methodologies that can be used to evaluate performance in Army command teams. Specific objectives include the following:

- Refine observational methodologies designed to assess the implementation and useability of digitised command support systems in HQ.
- Conduct preliminary data collection focussed on developing a map of team and task processes in HQ. Data generated from the objective observations will be fed into a behaviour systems model of HQ operation. Ultimately, this will allow predictions of changes in behaviour/performance that result from changes to the system input.

3. Collecting Observational Data in the Field

3.1 Overview

As was mentioned in the Introduction, it is necessary to have objective observational measures, subjective measures, and outcome measures in order to generate an adequate picture of C2 operation. To date, a large amount of effort has been spent generating reliable methods of collecting subjective data. For example, the NASA Task Load Index (TLX) is used as a standard way of assessing subjective workload, and structured interview techniques are used as a systematic way of collecting data on a subject's view of task and team characteristics. Additionally, war-game simulations generally have outcomes that can be correlated with other performance measures. In contrast, there has been a low emphasis on behavioural measures. This is largely because of the difficulties involved in the collection of the basic behavioural data from a field setting. The labour intensive nature of the work, combined with the need for an experienced observer has tended to dissuade researchers from attempting to collect this information. As was discussed, though, it is impossible to generate a complete picture of C2 operation without objective behavioural data. Consequently, the current section aims to provide clear guidelines on formal methods of collecting such data in the field.

It should be noted that the following reflects the authors' experiences in observational data collection, as well as an aggregation of concepts from the published literature (Altman, 1974; Bakeman, 1978; Crockett, 1996; Dunbar, 1976; Hinde, 1973; Hollenbeck, 1978; Lehner, 1979; Martin & Bateson, 1993; Noldus, 1991). Thus, it is difficult to provide an exact reference for specific aspects. Instead, the reader is referred to these papers as a source of information on field research

techniques. In addition, Appendix A provides a Glossary of standard field research terminology.

3.2 Formulate the Problem

One of the most important aspects of collecting data in a field setting is formulating the problem. Under no circumstances should the project attempt to observe everything. This is one of the most common errors made by inexperienced observers, and tends to lead to ill-defined observations that risk lapsing into the chaotic. A general problem we may seek to solve concerns identifying the behavioural indicators of cognitive functioning, and assessing whether they are correlated with other measures. A more specific problem may be to ask what tasks the Operations Cell of a Bde HQ perform, and how the individuals communicate the information necessary to fulfil their roles.

3.3 Identify the Critical Variables

If it is relevant, it is also important to identify the dependent and independent variables. It must be noted that in some case, the aim of the observations may be to build a topographic map of existing C2 behaviours, such as teamwork, that can be used to assist in guiding future system design. If this is the case, then the issue of dependent and independent is not applicable. If the goal is to examine the effect of a system such as BCSS on C2 team processes, the dependent variables will include communication, cognitive and physical workload, and frustration. These are behavioural variables. The independent variable in this case will tend to be the various components of BCSS. Other possible independent variables include communication architecture and team structure. It is important to notice that the independent and dependent variables are interchangeable. In a field setting, clear-cut variable boundaries tend not to exist, with distinctions hovering between the arbitrary and the outright fuzzy.

3.4 When to Collect Data

Another area of observational research that needs to be clearly defined is when the observations should occur. This can only be determined through preliminary observations. However, when it comes to a military exercise, it is usually necessary to attend for the full duration (using sampling techniques to collect the data). Only observing for peak activity periods will act as a cue to the subjects, and will bias the data (particularly if a behaviour taxonomy is the aim). In real world activities, observation will largely be opportunistic. Ideally, it would consist of at least three full days of observation spread across one week. While this time frame is somewhat arbitrary, it has been shown to be useful as a "rule of thumb" for conducting observational research projects (Lehner, 1979). To determine the duration systematically, it is necessary to perform a saturation sample pilot study. This involves observing everything for a week, identifying the points that give representative coverage, then going back and observing these points to test whether it is adequate. It must be noted that in a Defence setting, collecting the data necessary to perform a saturation sample study is not usually possible. As a consequence, wherever possible the above rule of thumb should be adopted.

3.5 Developing a Behaviour Taxonomy

In general, the first step is to formulate a list of well-named, clearly defined behaviours relevant to the research question. Important aspects of observational research are the behaviour categories and data parameters. This requires knowledge of the relevant literature, as well as preliminary observations in the research environment. Knowing what has been done before may avoid unnecessary repetition and may suggest possible methods of data collection. As will be discussed, a survey of the literature on team performance suggests clearly defined team and task categories. If, as is the current case, relevant categories have been suggested in the literature, preliminary observations can be used to assess whether they are relevant to the new context. If data is to be collected in a systematic fashion, the categories must also be clearly defined. A precise operational definition must be written out to ensure that observers do not drift from the original definition, and to enable other researchers to use the same system.

Generally, a select number of behaviours must be chosen to reduce the chances of being swamped while observing. During data analysis, the behaviours are often collapsed into function categories, or factors. It should be noted that there is a degree of arbitrariness to this process. As will be discussed, inter-observer ratings improve the reliability of information.

Once the relevant behaviours have been established, it is necessary to determine what data parameters are important. For example, is it important to know how often the behaviour occurs, how much time is spent in a behaviour, how long a bout of behaviour lasts once it is triggered, and/or what sequences of behaviour are important. It is also necessary to determine whether the identification of individuals is important, or whether it is the overall level of a particular behaviour within a group that is the critical parameter. If the focus is on social dynamics, individuals need to be identified. However, if the goal is to delineate tasks within a cell, individual data may not be necessary.

Once these issues are established, it is valuable to determine whether the research question is answerable with the data parameters chosen. This involves analysing some data as early as possible. It may be necessary to refine or even dramatically alter techniques. For example, collection may be focusing on rate of behaviour, when analysis shows that duration was a more appropriate measure. Something that can happen with inexperienced observers is that they leave data analysis until observations are complete, only to discover that the question remains unanswered.

Once preliminary observations are complete, developing a taxonomy is the first step in systematic observational research (it may even be the entire purpose.) Defining the behaviours is an essential aspect, but the detail depends on the specific question. The objective may be a comparison of two or more communication architectures with respect to qualitative and quantitative aspects of behaviour. Alternatively, it may be to develop a taxonomy of what exists to assist in the design of an appropriate decision support aid.

Several ways of describing behaviour may be used in a taxonomy. The physical description of behaviour may be "molecular". This includes minute detail of muscle or skeletal action. Alternatively, it can be "molar". A molar description of "walk"

might be a slow, quadrupedal locomotion. Behaviour can also be described in terms of its consequences. That is, it is defined in terms of effects. For example, "approach" has the effect of decreasing the distance between two subjects, regardless of how the action was performed.

A behaviour taxonomy might be restricted to discrete categories of behaviour, or if detailed sequences are not of interest, some tasks may be recorded as single units (for example, "issue command"). This compares to recording detail of the actions involved in issuing the command. The level we record depends on the problem at hand. Functionally organised taxonomies do have advantages. After experience develops, observers find that it makes sense to group specific behaviours into higher order functions, or into factors. This can be done during data analysis, and if there is enough data, factor analysis can be performed.

3.6 Exhaustive and Mutually Exclusive Recording Categories

For purposes of data recording and analysis, it can be an advantage to define categories that are both exhaustive and mutually exclusive. Exhaustive means that the subject is always observed as doing something, even if that something is "inactive". Mutually exclusive means that the subject is never recorded as doing more than one thing simultaneously. For example, they can be "travelling" or "approaching", but not both. In "approach", they are performing both actions, so recording "travel" is redundant. In such a situation, though, we would still want data for "travel" if "approach" were not occurring. Consequently, the recording system needs rules for establishing priorities, such as "approach" over "travel".

It should be noted that during an observational block, more than one set of mutually exclusive and exhaustive categories could be included. For example, you can score one behaviour, one location, and one relation simultaneously. By using clearly defined collection methods, different behaviours can be analysed separately and together to determine relationships.

3.7 Recording Behaviour

There are two kinds of events that activate the observer to record a score: a change in behaviour or the passage of time. A behaviour change scoring system usually involves recording the onset of a new behaviour, but may also include recording the termination of the current behaviour. Alternatively, the transition time between two behaviours may be recorded. Behaviour change scoring is usually associated with continuous sampling methods. However, for some behaviour, the transition from one bout to another can be ambiguous. In such cases, the behaviour taxonomy should include defining events that signal when a new behaviour should be recorded (eg. a certain number of seconds of inactivity). The second approach to recording behaviour involves time sampling. At the end of a predetermined time interval, the observer scores either the behaviour occurring at that point (scan, instantaneous or point sampling), or scores the occurrence or non-occurrence of each behaviour in the interval (one-zero sampling). The techniques for recording behaviour are described in detail in the following section.

3.8 Sampling Methods

Sampling methods are used to make estimates about the entire population based on a set of that population. It is just about impossible to observe the entire thing we seek to understand. Over the years, certain methods of sampling behaviour have been developed to reduce the possibility of bias. Even though a project might have pre-determined categories of things that are of interest, some categories might appear more interesting to the observer. If who, what or when to observe is left to the whim of the observer – and to his or her interests – data recording may end up focussing on some events to the exclusion of others. This is the essence of observer bias, and is one of the largest problems in observational research. To reduce the possibility of such bias, systematic sampling is used. The following details the numerous types of sampling that are used in observational data collection.

3.8.1 Ad Libitum Sampling

This is equivalent to traditional field notes, and generally involves non-systematic, informal observations preliminary to the quantified study. It is useful for recording rare, unusual events, and for identifying relevant parameters in the preliminary stages of an investigation. The "comments" column of a formal data-sheet can also be used for this, but care should be taken to ensure such comments do not become the focus of the research.

3.8.2 Continuous Sampling

In this method, all occurrences of specified behaviours and interactions are recorded. This behaviour-change method usually records behaviour shown by a focal subject, but can be modified to record focal behaviours, sequences, or locations. It also allows for the calculation of frequencies and rates of behaviour. If behaviour termination or transition times are also recorded, duration can be calculated. This method allows for the most complete record of behaviour and is the only way to collect sequences without missing anything. It can be very time-consuming and/or laborious if many behaviours or subjects are involved, and the tempo is rapid. However, a sheet can be designed to simplify data collection.

3.8.3 Instantaneous and Scan Sampling

These are time-sampling based systems in which the observer records the behaviour state at the instant ending a predefined interval – for example, on the minute – which is usually signalled by an auditory device heard only by the observer. By using such a device, the observer is not having to constantly check the time, and can concentrate on observing. To avoid bias, the observer only records what is going on at that point. A potential problem is the difficulty in identifying the behaviour at a single glance. Instead, it may require observing for 5 seconds to gauge what is occurring. The observer can then record the behaviour at the end of the 5 seconds.

Instantaneous sampling is used where one subject is observed, while scan sampling involves a group of subjects. In scan sampling, the observer must scan the group to record the behaviour of all individuals. To avoid bias, it is important that even the scan is systematic (for example, from left to right).

Instantaneous and scan sampling approaches are the easiest ways of estimating the percentage of time spent in specific activities. Thus, it is well suited to studies of workload. It is less useful for data on interactions since they often occur in sequences that cannot be recorded in a single scan. In addition, this method also misses infrequent behaviours of short duration, unless the interval between samples is very short or the entire observation is long. It is, however, a relatively simple method, and naive observers can be quickly trained in its use.

The appropriate interval length depends on several factors, including activity level (how often behaviour changes), group size (longer for more), or whether a single or mixed sampling strategy is adopted (most common in trained observers). The shorter the interval, the more the data represents that which would emerge with continuous sampling. Shorter intervals also mean more data to analyse, but it is important in rapid tempo operations. Longer scan intervals can be used during low tempo situations. However, they need to be combined with some continuous sampling to ensure that brief but important behaviours are recorded.

3.8.4 One-Zero Sampling

In one-zero sampling, time intervals are also used. However, each behaviour during the interval is recorded as having an arbitrary score of 1, regardless of its actual frequency. For example, a frequency of both 5 and 3 are recorded as "1", while 0 is entered if the behaviour was not observed. This does not allow the calculation of true duration, rate or percentage, so it is not advisable for data collection where high fidelity is important. It also over-estimates true percentage, when the results are compared with continuous data. However, it is easy, and does produce high inter-observer reliability. Consequently, it may be the appropriate method to adopt when trained observers are not available, or for getting estimates of behaviour levels.

3.9 Choosing the Sampling Period and Focusing the Observations

It is useful to divide observation periods into equal length sample periods. This assists check-sheet design, and data analysis. A basic observation period includes at least one complete replication of data collection: that is, each subject is observed a minimum of once in random order. In general, an observation period will last for ½ - 1 hour during faster tempo operations, and 2-3 hours when things are occurring at a slower tempo. As a rule of thumb, the duration should be shorter than the fatigue threshold of the observer. This is no longer than 2 hours in high tempo situations, and increases as the tempo decreases.

In addition, in a field/operational setting, the observer cannot pay attention to everything at the same time. Thus, during a sampling period, the observer restricts their focus. The most common focus is on a single individual (focal subject) such that all behaviours initiated by that subject are recorded. This may also include interactions that the focal subject has with other individuals. The focus, which can be any of the following, needs to be predetermined in the methodology:

1. Focal subject: Individual selected from total group, for example, Duty Officer (most effective if used with continuous sampling).

2. Focal subgroup: Related sub-set selected from total group, for example, the Duty Clerk and Duty Officer within the Operations Cell (most effective if used with continuous sampling).
3. Group or subgroup, one individual at a time: Duty Clerk and Duty Officer or entire Operations Cell (most effective if used with instantaneous/scan sampling).
4. All occurrences of certain behaviours: This is equivalent to focusing on the total group, while restricting attention to certain behaviours, such as communication.
5. Sequences of behaviour: Sequenced behaviours, such as those that occur during interactions, or while performing complex tasks. Individual identities and rates of occurrence may have to be sacrificed unless video or audio recorders are used.
6. Location: Focusing of attention on a particular location, such as the Operations Cell, and recording what events occur there.

To avoid observer bias, the order in which focal subjects or locations are sampled during an observation period needs to be randomised. Likewise, observation periods need to be balanced.

3.10 Collecting the Data

There are several ways of recording data, and they vary in the reliability, ease of use, cost and time required for transcription and analyses. A major problem with audio and videotape is that they usually require at least three times as much time to transcribe as to record. However, if rapid, unpredictable behaviours are occurring, recording them is the most successful way of ensuring that data are captured. One way to make transcription from audio or video less time-consuming is for the observer to narrate during the observations (as long as it is not disruptive to the subjects). This saves re-coding behaviour, and allows a 1:1 transcription ratio. Small laptop computers are also useful, and can be used with commercial data collection products such as The Noldus Observer Software. However, they can limit sampling to single method. As was mentioned, the most common method with experienced observers is for mixed-sampling methods to be used. In addition, transporting computer equipment around for data collection in a field setting can be cumbersome and extremely impractical. In a military setting, when movement around the field is reliant on Army transport, it is usually impossible to carry more than the basic necessities. Consequently, in most observation data collection situations, the "old-fashioned" pencil and paper method is usually the most appropriate.

3.10.1 Codes

Codes are useful for recording behaviour in many sampling scenes. Depending on how many behaviours are going to be scored, one may simply code each behaviour with one to three letters or numbers. If there are many behaviours, higher reliability will occur if mnemonic abbreviations are used (eg. AP = Approach). In addition, a dimensionalised coding system can be used where the first letter denotes a general category, while the second a specific behaviour. A teamwork example is "CR = Communicate-Request". Codes can also be used to identify individuals and locations and to discriminate between actors and recipients.

3.10.2 Data Sheets

As was mentioned, for many field projects, a data sheet is a simple and inexpensive way of recording data. The data sheet will reflect sampling methods, information to be recorded, number of subjects, duration of sample period and method of analysis (hand or computer). Each sheet should include project title, date, time, weather (if applicable), observer, subject/s, phase and/or condition, and trial number (if applicable). There should also be a space for comments (Ad Libitum type). It is not unusual for several data sheets to be trialed before one is chosen for formal data collection. Issues to be considered include methodology, behaviour categories, sample rate, and the organisation on paper of the behaviours in a way that facilitates data collection. Categories can be organised in terms of their tempo, functional organisation, or can simply be alphabetical. Figures 1 to 6 provide example data sheets for the various sampling methods.

In general, behaviours are recorded in the columns, while time is recorded in rows. Behaviours are recorded by making a check mark/tick in the appropriate cell, or inserting the code. If the codes have to be written, the box needs to be large enough to accommodate the chosen symbols. This method works for continuous and scan sampling. To record sequences of behaviour, codes for actors, behaviours and recipients can be written in the order in which they occur (Figure 6). This can be done within a time interval or at the onset of the behaviour sequence. It is also possible to use a matrix. For example, individuals or behaviours can be located across the top of the form, while locations or behaviours can be presented down the side. This approach uses a specified duration per sheet (eg. per 30 minutes). Thus, it still gives crude temporal patterns across long cycles, and allows analysis of relationships between variables.

If location is a critical variable, an alternative approach to the check sheet is to use an actual map. The observer simply marks the map with a behaviour or an individual code at each interval. This allows analysis of the efficiency of movement, task and/or individual locations.

Project: *The Effect of BCSS on Workload* Date: *31/03/2003* Time: *1300-1330*
Observer: *VM* Subject: *OPS Cell* Phase: *No BCSS* Trial Number: *3*

Interval	Beh. 1	Beh. 2	Beh. 3	Beh. 4	Beh. 5	Other	Not Visible	Comments
0:00:30	✓							
0:01:00						✓		
0:01:30							✓	
0:02:00				✓				
0:02:30		✓						
0:03:00		✓						
0:03:30				✓				
0:04:00	✓							
0:04:30						✓		
0:05:00						✓		
Total	2	2	0	2	0	3	1	10 scans
Percent	20%	20%	0	20%	0	30%	10%	100%

Figure 1. Data sheet used for scan sampling of mutually exclusive and exhaustive specific behaviours. Note that each interval has a tick, and there is only one per row. Also, the sheet contains detail on project, date, time, observer, subject, phase, and trial number.

Project: *The Effect of BCSS on Workload* Date: *31/03/2003* Time: *1300-1330*
Observer: *VM* Subject: *OPS Cell* Phase: *No BCSS* Trial Number: *3*

Interval	Location			Behaviour			Not Visible	Comments
	Loc. 1	Loc. 2	Loc. 3	Beh. 1	Beh. 2	Beh. 3		
0:00:30	✓				✓			
0:01:00			✓			✓		
0:01:30			✓					
0:02:00				✓				
0:02:30		✓						
0:03:00		✓						
0:03:30			✓	✓				
0:04:00	✓							
0:04:30							✓	
0:05:00			✓			✓		
Total	2	2	5	2	1	2	1	15 scans
Percent	20%	20%	50%	20%	10%	20%	10%	

Figure 2. Data sheet used for recording mixed scan categories. At each interval, either a location or "not visible" is recorded (mutually exclusive and exhaustive). One of the behaviours may also be checked.

Project: *The Effect of BCSS on Workload* Date: *31/03/2003* Time: *1300-1330*
Observer: *VM* Subject: *OPS Cell* Phase: *No BCSS* Trial Number: *3*

Time	Beh. 1	Beh. 2	Beh. 3	Beh. 4	Beh. 6	Beh. 7	Other	Comments
0:00:30	✓							
0:01:00								
0:01:30			✓✓✓✓				✓	
0:02:00				✓✓				
0:02:30								
0:03:00		✓						
0:03:30								
0:04:00	✓✓✓							
0:04:30								
0:05:00				✓		✓	✓✓	
Total	4	1	4	3	0	1	3	= 16 onsets

Figure 3. Data sheet used for recording behaviour frequencies of specific behaviours. Each time the onset of a behaviour is observed, a tick is recorded in the relevant time interval. Multiple observations can occur per interval, and some rows may have no data as no new onsets have occurred.

Project: *The Effect of BCSS on Workload* Date: *31/03/2003* Time: *1300-1330*
Observer: *VM* Subject: *OPS Cell* Phase: *No BCSS* Trial Number: *3*

Interval	Scan			Continuous Frequency			Not Visible	Comments
	Beh. 1	Beh. 2	Beh. 3	Beh. 1	Beh. 2	Beh. 3		
0:00:30	✓				✓✓✓			
0:01:00			✓			✓✓		
0:01:30			✓					
0:02:00				✓				
0:02:30		✓			✓✓✓✓			
0:03:00		✓						
0:03:30			✓	✓				
0:04:00	✓							
0:04:30		✓	✓					
0:05:00			✓			✓		
Total	2	3	5	2	7	3		
Percent	20%	30%	50%					

Figure 4. Mixed sampling data sheet for recording scan and continuous data. Scan data are recorded at the beginning of the interval, and continuous data are recorded throughout the interval.

Project: *The Effect of BCSS on Workload* Observer: *VM*	Subject: *OPS Cell*	Date: *31/03/2003* Phase: *No BCSS*	Time: *1300-1330* Trial Number: *3*					
Time	Beh. 1	Beh. 2	Beh. 3	Beh. 4	Beh. 6	Beh. 7	Other	Comments
0:00:30	1	1	0	0	0	1	0	
0:01:00	0	0	0	0	1	1	0	
0:01:30	0	0	0	0	0	0	0	
0:02:00	0	1	1	0	0	1	1	
0:02:30	0	0	0	0	0	0	0	
0:03:00	0	0	1	1	0	0	0	
0:03:30	1	1	0	0	0	0	1	
0:04:00	0	1	1	1	1	1	1	
0:04:30	0	0	0	0	0	0	0	
0:05:00	1	1	0	0	0	0	0	
Total	3	5	3	2	2	4	3	
Percent	30%	50%	30%	20%	20%	40%	30%	

Figure 5. Data sheet for recording one-zero interval. A "1" is entered if the behaviour is observed at any frequency during the interval. Rather than being a true percentage of behaviour levels, this gives a measure of the percentage of time in which the behaviour was observed.

Project: *The Effect of BCSS on Workload* Observer: *VM* Subject: *OPS Cell*	Date: *31/03/2003* Phase: *No BCSS* Time: *1300-1330* Trial Number: *3*	
Interval	Behaviour coded in sequence	Comments
0:00:30	ACFD	
0:01:00	ADDFG	
0:01:30	BBCBA	
0:02:00	A	
0:02:30	A	
0:03:00	CBCA	
0:03:30	DEDFGEE	
0:04:00	AABAB	
0:04:30	GEEA	
0:05:00	CBCA	

Figure 6. Data sheet for recording sequences of behaviour

3.11 Replication and Inter-Observer Reliability

A critical component of observational data collection is inter-observer reliability. The methods used must be clear and defined enough to be easily replicated. This means that unequivocal behaviour definitions are particularly important. It is also important for a high level of intra-observer reliability. This ensures that the observer is reliable from session to session.

Inter-observer reliability is tested by having at least two observers collect data simultaneously. Testing intra-observer reliability requires video or audio records, with the observer coding the same set of data at least twice. The duration of an observer reliability session should be equivalent to the observation period. For fast tempo observations, the reliability test should cover ½-1 hour of data collection, while this should be increased to 2-3 hrs during slower tempo observations. The data are then compared, and a percentage of agreement is calculated, using the following formula: % Agreement = (Agreements/Agreements + Disagreements) x 100. 85% is considered to be an acceptable level of agreement. As well as the crude percentage, there are also statistical methods that take chance agreement into account (eg. Kappa scores) (Lehner, 1979).

4. Categories of C2 Behaviour

4.1 Existing Categories of Team Behaviour

Before conducting preliminary observations, it is important to examine the literature to see if existing categories and/or taxonomies have been determined. As mentioned in the Introduction, navy and aviation C2 teams have been extensively studied in the U.S. This work has delineated numerous factors related to team performance, as well as a taxonomy of battle command. Table 1 presents a summary of teamwork factors that have emerged from previous research, and a description of the associated observable behaviours.

Table 1. Teamwork dimensions and observable behaviours

Dimension	Definition	Observable Behaviours
Assertiveness	The willingness to make decisions and act on them, to defend decisions, and to admit ignorance and ask questions.	• Ask clarifying questions • Maintain position if challenged • Make suggestions • Offer opinion in decisions
Mission Analysis/Decision Making	The degree to which the team uses sound judgement, to select the best course of action, based on available information.	• Define tasks in terms of mission requirements • Identify short and long term plan • Critique plan • Gather information • Cross-check information • State contingencies/alternatives • State consequences of actions • State implications of unplanned events • Allocate and monitor resources
Adaptability/ Flexibility	The degree to which the team is able to alter plans/decisions in the face of changing conditions.	• Alter course of action • Step in and help others faced with problem • Redistribute workload • Reorganise the team roles • Monitor each other's behaviour
Situation Awareness	The degree to which the team maintains an accurate and predictive perception of the external environment.	• Identify problems • Detect situations that require corrective action. • Provide updates of where team is in relation to achieving goals • Identify impediments to goal attainment. • Provide important information prior to request • Anticipate changes in the situation • Anticipate needs of other team members

Leadership	The degree to which a team member directs and coordinates the activities of other team members and monitors team performance. If there is clear delineation of task duties before task, leadership is spread throughout the crew and is not limited to a formal leader.	• Specify task to be assigned • Ask for input in plans/decision • Focus team attention on current task • Provide feedback to team • Explain to others what is required • Listens to concerns
Communication	The degree to which the team clearly and accurately sends and acknowledges information, instructions, or commands.	• Use standard terminology • Acknowledge communication by others • Verify information • Provide information when requested • Repeat vital information

4.2 Relationship with Performance

A wealth of research has demonstrated that these factors are correlated with performance. It is beyond the scope of this report to provide a detailed summary of the literature on correlates of team performance. Instead, the following is a sample of the findings, while the reader is referred to the literature for greater detail (Brannick, Prince, Prince & Salas, 1995; Cannon-Bowers & Salas, 1998; Entin, & Serfaty, 1999; Orasanu & Salas, 1993; Serfaty, & Entin, 1997; Serfaty, Entin & Deckert, 1994; Stout, Cannon-Bowers, Salas, & Milanovich, 1999).

In high workload situations, more effective teams adopt communication and coordination strategies that reduce the effort needed to meet task demands while maintaining performance levels (Entin, & Serfaty, 1999). Orasanu and Salas (1993) found that the conversations of effective teams were characterised by a high level of homogeneity. The team members adopted conventionalised speech patterns that appeared to facilitate coordination. Low performing teams had speech patterns that were heterogeneous and less predictable. This created more work when the task required interaction.

In high stress situations, effective crews are also more explicit in defining the problem, articulating plans and strategies for coping, obtaining relevant information, explaining the rationale, and allocating and coordinating responsibilities among the crew. The suggestion is that teams build a shared mental model (SMM) of the situation. In terms of mission analysis, more effective teams have been observed to engage in more planning types of behaviour than less effective teams. In more effective teams, the leader uses low workload periods in the mission to make plans. This helps to build the SMM, and to allow commands to take on contextual meaning (Stout, Cannon-Bowers, Salas, & Milanovich, 1999). More effective teams also have SMMs for the majority of key taskwork knowledge areas. In addition, they have higher consensus levels for critical teamwork constructs (Pascual, 1999).

Teams that rely solely on implicit coordination are overwhelmed by problems during crisis situations (Orasanu & Salas, 1993). Team effectiveness appears to be enhanced when team members provide information before they are requested to do so. Providing information in advance appears to be particularly beneficial in situations characterised by increased workload (Stout, Cannon-Bowers, Salas, & Milanovich, 1999). The strategy of anticipating changes in the situation and needs of other team members contributes significantly to the team's effective performance under stress, and appears to be the reason such teams perform consistently better under a range of tactical conditions (Serfaty, & Entin, 1997).

A further demonstration of the importance of communication and coordination is that error often occurs as a consequence of staff shift rotation. Critical pieces of information, key operational assumptions, cognitive focus, and shared situation awareness can all be lost or misinterpreted in the hand-over process. To be effective, the distributed decision making team needs to develop and successfully transition a minimal sensible structure from one staff shift to the next (Leedom, 1999). A critical difference between effective and ineffective shift changeover relates to how well the teams coordinate (Cannon-Bowers & Salas, 1998). Highly reliable teams emerge if communication lines are open and flexible (Serfaty, & Entin, 1997).

In C2, the team must also be adaptable. The ability to adapt to a dynamic environment lies at the heart of a team's performance and robustness to error (Serfaty, Entin & Deckert, 1994). The members must be able to adapt to unpredictable and uncertain conditions. They achieve this by redistributing workload or reorganising the team's roles, monitoring each other's behaviour (to catch and correct errors), and giving each other constructive feedback designed to improve performance (Cannon-Bowers & Salas, 1998). When faced with an increasingly demanding task environment, the effective team will adapt its decision making strategies, and even its structure to manage the task (Serfaty, Entin & Deckert, 1994).

4.3 An Existing Taxonomy of Team Behaviour

As well as identifying critical team factors, behavioural observations can be used to establish a taxonomy of a particular domain. A previous example, established by Leedom (1999), centred on cataloguing behaviours into steps involved in training proficient battle command. The following provides a summary of Leedom's taxonomy, while full detail can be found in the original article.

1. Clarify expected roles and contributions.
2. Establish a clear strategy for knowledge management.
3. Establish information exchange practices.
4. Align decision authority with decision making capacity.
5. Employ proper mix of decision strategies.
6. Effectively manage collaborative debate.
7. Sequence and communicate decisions and assumptions.
8. Employ proper mix of production strategies.
9. Balance push-pull of information flow to decision makers.
10. Maintain attentional scanning across multiple decision threads.
11. Verify key information inputs and employ risk management.
12. Manage battlespace images and cognitive influence.
13. Anticipate and prepare for the emergence of complexity.

14. Manage task priorities, task sequencing, and information cost.
15. Manage errors with start rotation and handover.
16. Practice self-critique and organisational learning.

An element of this research is to assess whether the team factors and processes involved in establishing such a taxonomy can be formally observed in Australian Army HQ. If so, an objective is to establish the critical parameters for measuring these dimensions. A longer-term goal is to generate the taxonomy of C2 behaviours and processes, and feed such information into a Behaviour Systems model.

5. Exercise Rhino Charge 2000 (Ex RC00)

As part of the refinement and validation process, it is necessary to attend exercises in a purely exploratory/preliminary manner. This allows for the identification and refinement of categories, in terms of operational definitions and sample rate. During February 2000, a low risk operational search exercise was conducted by 9 Bde in Adelaide, South Australia. This exercise was seen by the analysts as the ideal opportunity to go through this process during slower tempo operations. This is a major advantage during the development stage of observational research. In particular, the analysts are not swamped by the pace of the situation while trying to code behaviour, as may occur if this was attempted in a high tempo scenario. Once behaviours are identified, the transition to faster tempo situations is far easier.

6. DSTO Personnel

Table 2 provides details of DSTO personnel who participated in preliminary data collection at Ex RC00. All four analysts are from Land Operations Division.

Table 2: DSTO personnel details

Name	Role
Dr Vanessa Mills	Coordinator and methodology refinement, Observer
Ms Christina Stothard	2IC and methodology refinement, Observer
Mr Sam Huf	Observer
Mr Peter Williams	Observer

7. Methodology

7.1 Participants

Military participants consisted of a combination of regular army and army reservists from 10/27 Regiment, 9 Bde. The participants were undergoing operational search training in order to support Operation Gold, as well as future protective operations. As part of the exercise, participants were required to:

- Operate a Battalion Command Post (Bn CP) to provide C2 for the conduct of the Search Exercise from 22 to 27 Feb 00;

- Provide a Company HQ (CHQ) to provide C2 for the Hampstead Barracks, including platoon recall and search task coordination from 22 to 27 Feb 00;
- Provide a minimum of four operational search platoons for the search exercise 22 to 27 Feb 00.

7.2 Materials

Table 3 summarises the data collection tools that were used at the exercise. As was mentioned, the focus was on the more objective observational techniques. Nonetheless, the questionnaires were administered in order to assess whether the questions held relevance in an army HQ. In the past, the Teamwork Questionnaire has only been administered to military personnel during the Military Appreciation Process, while the NASA TLX has not been used in an Australian Army HQ. Appendix B contains copies of the draft proformas used to refine and collect data.

Table 3: Data collection tools trialed at exercise

Name	Purpose	Data Collection Technique	Time Required from HQ personnel
Team Behaviour Measurement (Draft)	Determine team performance	Observations during exercise	N/A
Objective Taskload Measurement (Draft)	Determine C2 taskload and structure	Observations during exercise	N/A
Teamwork Questionnaire	Assess subjective team performance	Questionnaire given at end of shift/task	10 minutes
NASA TLX	Assess subjective workload	Questionnaire given at end of shift/task	5 minutes

7.3 Procedure

7.3.1 Attendance Schedule

Table 4 summarises the attendance by the analysts during the exercise. Observations were conducted at Battalion HQ (Hampstead Barracks, Building 64), and Company HQ (Football Park). The advantage of observing two types of HQ is that if the tools were useful at both, it would demonstrate a high degree of cross-situational generality.

Table 4: Attendance schedule of DSTO personnel at Exercise Rhino Charge

Date	Attendance Hours	Analysts	Purpose
22/2/00	1800-2400	Mills, Stothard, Williams	Familiarisation/Preliminary Observations: Battalion HQ
23-24/2/00	1800-0400	Mills Huf	Refinement of data collection techniques: Battalion & Company HQ
24-25/2/00	1800-0400	Mills Huf	Refinement of data collection techniques: Battalion HQ
25-26/02/00	1800-0400	Stothard Williams	Data collection: Battalion HQ
26-27/02/00	1800-0400	Stothard Williams	Data collection: Company HQ

7.3.2 Familiarisation and Preliminary Observations

On the first night of the exercise, the aim was to become familiar with the surroundings, the personnel, and the nature of the exercise. This involved mapping the structure, identifying the individuals, and listing their key duties.

7.3.3 Determining Category Parameters

Nights 2-3 were spent determining teamwork and taskwork category parameters. This consisted of observing the various HQ personnel for extended durations and performing the following steps:

1. Assess whether behaviour is observable. Table 5, in Section 8.1.2, lists the teamwork categories that were examined at the exercise. Taskwork categories were not pre-determined. Instead, the goal was to decompose key duties into physical and cognitive load, and temporal organisation.
2. Identify possible sampling methods (eg. continuous, focal subject, behaviour, etc.).
3. Identify sample interval and period (eg. 2 minute intervals across 1 hour).
4. Develop draft data sheet
5. Test sampling techniques for the different behaviours.

7.3.4 Collecting Trial Data

Nights 4-5 were spent collecting trial data using the developed methodology. It should be noted that during each observation period, only one of the observers was a Human Factors specialist. The other observer was familiar with military exercises, but unfamiliar with team process data recording. The advantage of using this observer was that it allowed an assessment of whether a naive observer could readily recognise categories that a Human Factors specialist had identified.

8. Results/Discussion

8.1 Familiarisation and Preliminary Observations

8.1.1 10/27 Regiment: Battalion and Company Headquarters

The Battalion headquarters consisted of the following roles/cells:

- Officer in Charge: Assumed overall responsibility for Headquarters.
- Two Liaison Officers (LOs): These roles pertained to the specific units, and were sometimes deployed to area of operations (AO).
- The Operations Cell (OPS). Included following individuals:
  1. Duty Officer: Assumed local responsibility for OPS. Also acted as second in charge (2IC), reporting up to CO when necessary.
  2. Duty Clerk.
  3. Signals Officer.
- High-risk search cell: The role of this cell was to give expert advice on search operations. They were sometimes deployed to the area of operations. Consisted of 1-2 individuals.
- Intelligence Cell (INT): Collated intelligence and conducted analysis of ongoing information. Consisted of the following individuals:
  1. Intelligence officer.

2. 2IC.
3. Duty Man: Responsible for admin/paper work.
4. Floating member: Used to assist in rotation.

The Company HQ was a mobile unit stationed on site at the AO. It was a similar structure to Battalion HQ, but consisted of only an OPS cell.

8.1.2 Team Category Parameters

8.1.2.1 Observable Team Behaviour

Table 5 lists the teamwork categories that were examined at the exercise, and identifies the behaviours that were observed. As can be seen, at least three behaviours from each category were detected. This suggests that the formal collection of observational data on team processes is viable. *Mission analyses/decision making* was the category with the lowest ratio of observed behaviours (3 out of a possible 10). Rather than suggesting that the category is not useful, this result is probably an artefact of when observations were conducted. Because the exercise was conducted over 24 hours, planning occurred during the day. It was not possible for the analysts to attend day and night sessions, meaning that no observations were conducted during the planning process. It is important, then, for future effort to focus on trialing the method during the MAP process.
One problem that emerged from the observations was a degree of redundancy with several of the actions. In particular, it was difficult to distinguish between the following behaviours that constituted Assertiveness and Communication:

1. Ask for clarification/Ask for clarification of information
2. Volunteer suggestion/Volunteer information

While an experienced observer can recognise the qualitative difference between these behaviours, confusion could arise with less experienced observers, particularly during high tempo observations. The suggestion is that the categories are removed from Assertiveness, and are recorded solely as Communication. While this does decrease the fidelity of the data, it will increase its consistency.

A further behaviour category suggested for removal is "Use standard terminology". While this is an important aspect of team processes and the development of shared views, recording it means ticking almost every utterance that emerges from subjects. A far more manageable approach is for recording by exception. The observer should record the behaviour when the subject uses non-standard terminology.

8.1.2.2 Team Behaviour Sampling Methods

Teamwork behaviours were more likely to consist of brief events, so the behaviour-change method of continuous sampling was the most appropriate technique. Scan sampling risked missing infrequent team behaviours, while one-zero sampling was considered too crude a measure for the process.

Observations were focussed at the level of "Group" (eg. Operations Cell), and all occurrences of the team behaviours were recorded. This was largely a pragmatic issue in the sense that it was not physically possible to observe more than one cell at a time. Because the tempo was relatively slow, observations were divided into 2 hour sample periods, with data recorded within 5 minute intervals.

Figure 7 shows the draft data sheet that was trialed during the exercise. The design is aimed at allowing observation of multiple subjects and a number of behaviours classified within the appropriate factors. It should be noted that this data sheet is aimed at more experienced observers, as it relies on the use of multiple codes. However, it does allow quite detailed data collection on team processes. If naive observers have difficulty in entering coded behaviour in such detail, they are able to tick the box when the higher order factor is observed.

Table 5: Teamwork categories and observable behaviours. Redundant or meaningless behaviours have been crossed out.

Factor	Behaviour	Observed
Assertiveness	~~Ask for clarification~~	✔
	Maintain position when challenged	
	~~Volunteer suggestion~~	✔
	Offer opinion on decision	✔
	Correct mistakes	✔
Mission Analysis/Decision Making	Define tasks in terms of mission requirement	
	Identify short term plan	
	Identify long term plan	
	Critique plan	
	Gather information	✔
	Cross-check information	✔
	State contingencies/ Alternatives	
	State consequences of actions	
	State implications of unplanned events	
	Allocate and monitor resources	✔
Adaptability/ Flexibility	Alter course of action	
	Assist other faced with problem	✔
	Redistribute workload	
	Reorganise team roles	
	Monitor other's behaviour	✔
Situation Awareness	Identify problem	✔
	Detect situation that requires corrective action.	✔
	Provide update of where team is in relation goals	✔
	Identify impediments to goal attainment	
	Provide information prior to request	✔
	Anticipate change in the situation	
	Anticipate need of other team member	
	Ask for clarification of tasks (the task is to…)	✔
	Clarify roles (your job is to…)	✔

Factor	Behaviour	Observed
Leadership	Specify task to be assigned	✔
	Ask for input in plans/decision	✔
	Focus team attention on current task	
	Provide feedback to team	✔
	Explain to others what's required	✔
	Listens to concerns	✔
Communication	Request information	✔
	Volunteer information	✔
	Ignore request for information	
	Provide information when requested	✔
	Repeat vital information	✔
	Pass instructions/ give orders	✔
	Ask for repeat of what was said (couldn't hear)	✔
	Acknowledge communication	✔
	Ask for clarification of information	✔
	Verify information	
	~~Use standard terminology~~	✔
	Use non-standard terminology	✔
	General discussion of task issues	✔
	Asking for quiet/no chatter	✔
Morale	Banter	✔
	Sarcastic/belittling tone	✔
	Humorous tone	✔

Project: *Team Performance Measurement* Date: *24/0/2000* Time: *2100-2300* Observer: *VM* Subject: *OPS Cell*

Time	**Assertiveness**			**Mission Analysis/ Decision Making**			**Adaptability/ Flexibility**			**Situation Awareness**			**Communication**			**Leadership**			**Morale**			Comments
	Duty Officer	*Duty Clerk*	*Signals Officer*	*Duty Officer*	*Duty Clerk*	*Signals Officer*	*Duty Officer*	*Duty Clerk*	*Signals Officer*	*Duty Officer*	*Duty Clerk*	*Signals Officer*	*Duty Officer*	*Duty Clerk*	*Signals Officer*	*Duty Officer*	*Duty Clerk*	*Signals Officer*	*Duty Officer*	*Duty Clerk*	*Signals Officer*	
0:05:00																						
0:10:00																						
0:15:00																						
0:20:00																						
0:25:00																						
0:30:00																						
0:35:30																						
0:40:00																						
0:45:30																						
0:50:00																						
0:55:00																						
1:00:00																						
1:05:00																						
1:10:00																						
1:15:00																						
1:20:00																						
1:25:00																						
1:30:00																						
1:35:30																						
1:40:00																						
1:45:30																						
1:50:00																						
1:55:00																						
2:00:00																						
Total																						

Figure 7. Data sheet used for recording frequencies of team behaviours. Each time a behaviour is observed, a code is entered in the relevant time interval. NB. Actual data sheet displayed one hour per A4 page. This allowed boxes to easily fit codes.

8.1.3 Taskwork Category Parameters

8.1.3.1 Observable Task Behaviour

As was mentioned, the taskwork categories were not pre-determined. Goals and key duties were identified on the first night, while nights 2-3 were spent assessing whether it was possible to classify the tasks in terms of physical and cognitive load, temporal organisation. It should be noted that the Officer in Charge, LOs, and Search Cell were rarely present in the HQ meaning that observations of task work focussed on OPS and INT.

The general roles of OPS and INT are described in Section 8.1.1. Because of the limited time available for observations, and the focus on team behaviour, it was not feasible to perform a detailed task analysis. Instead, it was only possible to produce crude measures of workload. Table 6 details the factors and examples of the observable actions. As can be seen, measuring physical load was relatively straightforward, with activities coded into basic actions. It was also possible to record details of how the task was performed, including mode of communication, the medium used for transmission of communication, method by which

communication was stored or displayed to group, as well as the origin/destination of the action. Likewise, temporal load could be measured by calculating total time taken to perform a specific task, as well as the sequence in which actions were performed.

Table 6: Taskwork categories and observable behaviours

Factor	Description	Actions	Mode/Medium/Storage/Origin/Destination
Physical Load	Manage Information Operate equipment	Create message Receive message Read message Forward message Store/File message Transcribe Information Update Map Use Phone Use Radio Operate computer	Text/verbal Electronic/paper/manual Overlays/Map, Status board, meetings/orders groups, radio/CP logs Higher/Lower/Cell
Temporal Load	Time taken to perform task Sequence in which are actions performed		

A critical element of examining taskwork is identifying behavioural indicators of cognitive function, such as information processing and problem solving. This was a far more difficult aspect of the observational data collection process, and requires ongoing preliminary research. It may be the case that observational methods are not a feasible way of generating such data, and that Applied Cognitive Task Analysis (ACTA), as suggested by Klein (1997), is a more appropriate methodology. The only drawback to using ACTA is that it requires lengthy structured interviews with subject matter experts. Access to military personnel for an extended interview is often not possible. The suggestion is for continued preliminary research on methods of inferring cognitive processes and frustration using observational techniques. It would also be valuable to further explore ACTA to assess whether it can be conducted in a manner that reduces the amount of time required from military personnel.

8.1.3.2 Taskwork Sampling Methods

Because they tend to consist of behavioural states, instantaneous scan sampling will be the appropriate method of measuring taskwork categories. In a low tempo operation, such as EX-RC00, a 5 minute sample was found to be adequate to generate an accurate representation of behaviour. In faster tempo scenarios, it may be necessary to increase this to a 1 minute sample rate. However, such a decision can only be made after a preliminary observation period (as occurred on the first night of EX RC00).

8.2 Trial Data

Figures 8 to 12 display the data on team behaviour collected during EX RC00. Mission Analyses/Decision making was not observed at a level that could be graphed. As was mentioned, future research should focus on monitoring these behaviours during the MAP to determine the usefulness of the category. It must also be emphasised that these data serve as an assessment of the usefulness of the

measuring team behaviour using this approach. The observations are not intended to be diagnostic of the performance of personnel during the exercise.

The data suggest that the categories are a viable method of developing a taxonomy of team behaviour in Army HQ. Such a taxonomy can then be used to generate a Behaviour System of HQ functioning that can be used to guide command support system design.

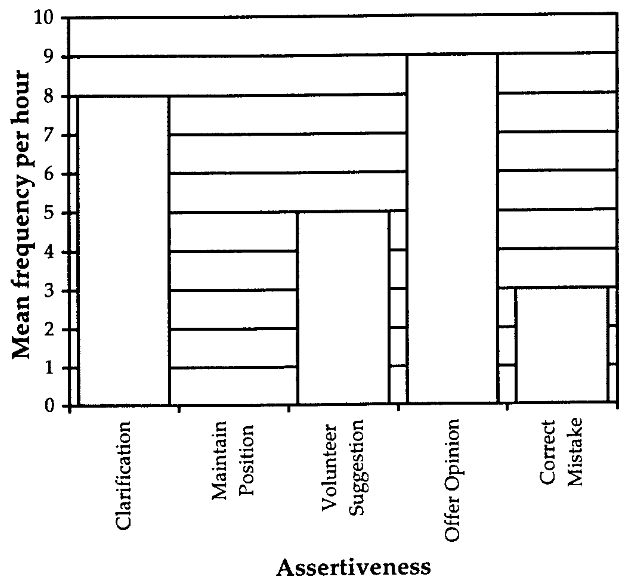

Figure 8. Mean frequency per hour of Assertiveness in OPS cell at Bn and CHQ

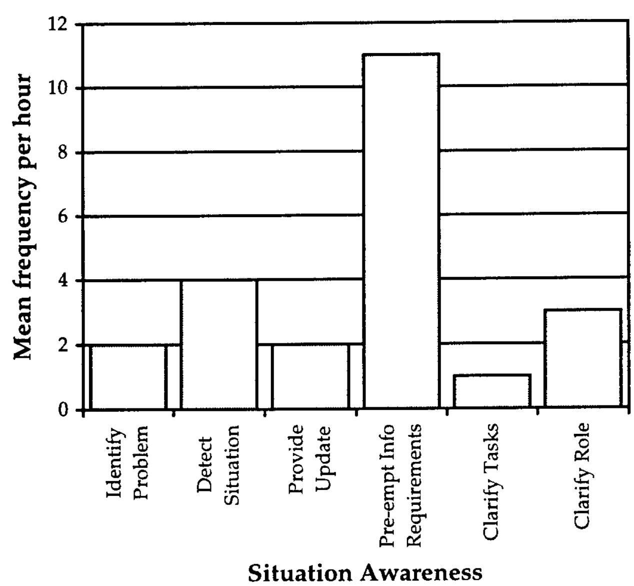

Figure 9. Mean frequency per hour of Situation Awareness in OPS cell at Bn and CHQ

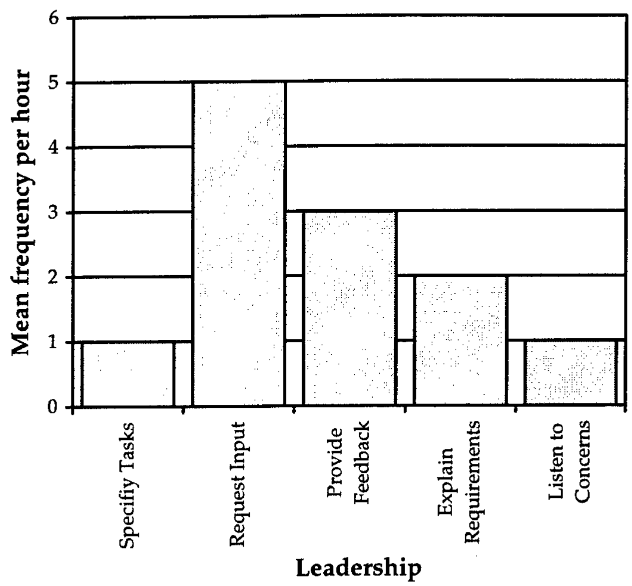

Figure 10. Mean Frequency per hour of Leadership in OPS cell at Bn and CHQ

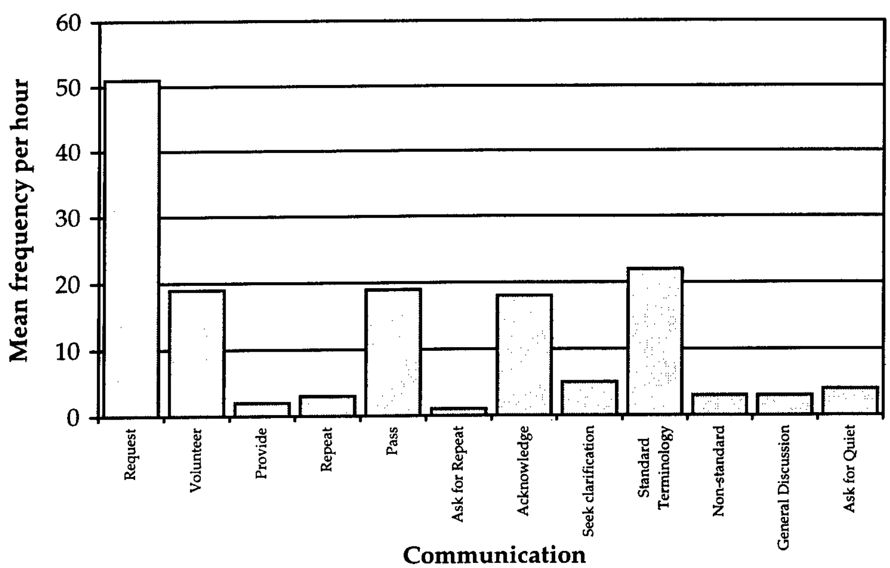

Figure 11. Mean Frequency per hour of Communication in OPS cell at Bn and CHQ

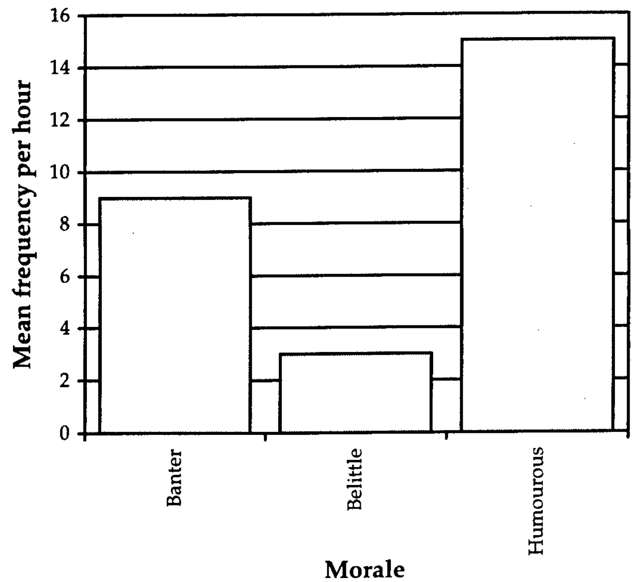

Figure 12. Mean Frequency per hour of Morale in OPS cell at Bn and CHQ

8.3 Comparing Team Processes

Using the above data on Situation Awareness and Communication as a basis, the following figures illustrate a hypothetical comparison that could be made of a HQ with and without BCSS using this type of data. The first thing that could be assessed is whether there were qualitative changes in team processes: Does the pattern of behaviour change as a consequence of the new system? In the following Situation Awareness example (Figure 13), there is a large increase in "clarify tasks", and a decrease in "pre-empt information requirements". This outcome would suggest a reduction in team cohesiveness under the new system. In light of the published literature on the area, this would suggest a reduction in performance, an outcome diagnostic of the need for either increased training or changes to the system. In the Communication example (Figure 14), there is an increase in information requests with the new system. Ideally, the data would be correlated with other outcome measures to assess whether the altered behaviour did predict a change in performance.

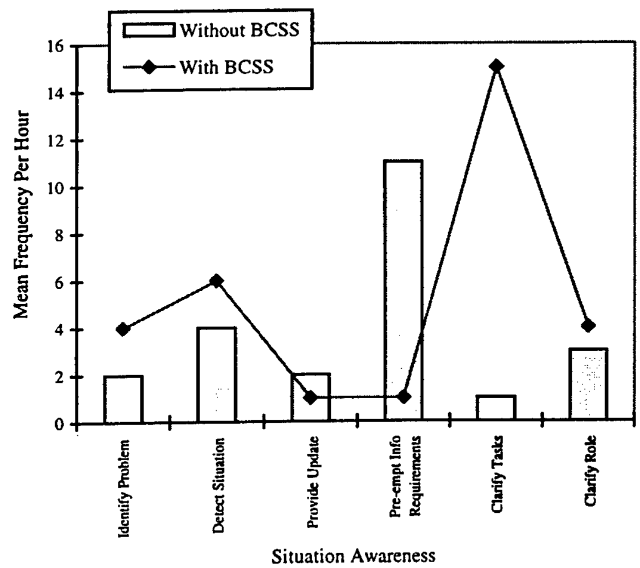

Figure 13. Hypothetical comparison of situation awareness in OPS cell with and without BCSS

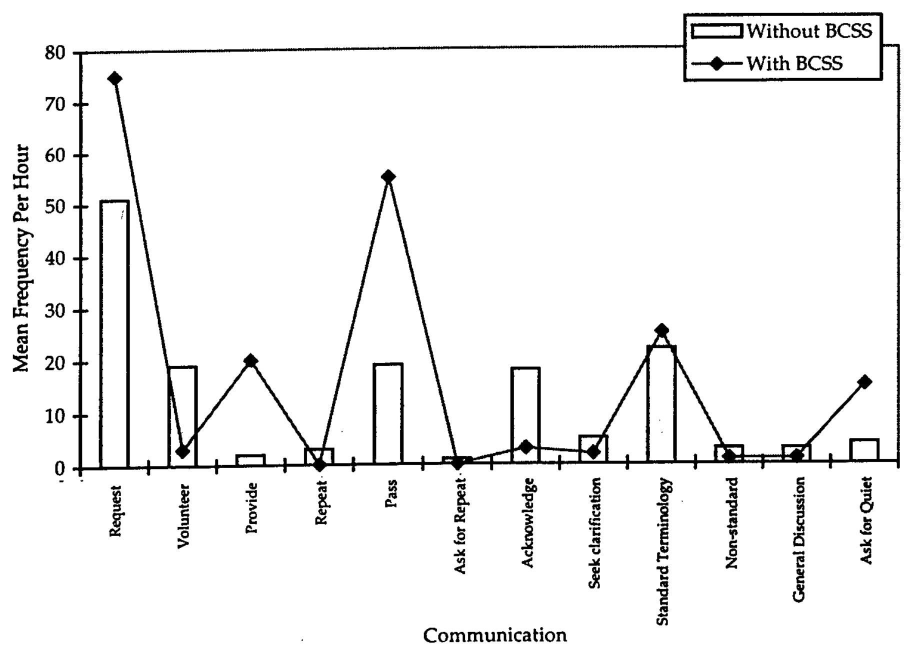

Figure 14. Hypothetical comparison of communication in OPS cell with and without BCSS

8.4 Collecting Data in Army HQ During Military Exercises

While the methodology does appear to offer a viable method of collecting data in the field, it is important that appropriate processes are followed to generate the data. The following summarises the steps that should be followed to collect team and task data

in army HQ. It should be noted that these instructions act as a guide to experienced observers, who would then train the naive observers in the techniques.

Before arriving at the exercise or operation, it is vital that the research objective is clearly established. This will ensure that the steps that need to be followed during the exercise are directed, and maximum use is made of attendance. In the current case, the main objective would be to map out team and task processes in the HQ. On Day 1 of attendance, the analysts should become familiar with the surroundings and the personnel within the HQ. It is also important that the subjects do not perceive the observers as obtrusive or threatening in any way. Clear explanations need to be provided in terms of the purpose of the observations.

Once familiarisation is complete, Day 2 should be spent determining data collection techniques. This involves identifying the different cells present in the HQ (eg. INT, OPS, LOG, etc.), mapping out the physical layout (including all of the equipment), and listing the key duties that the personnel perform. Once this is complete, the analysts should determine observable actions, and code the actions into categories and higher order factors. Data sheets can then be modified to suit, and then tested by spending 1-2 hours observing HQ. If problems are apparent, revisions should be made, and the sheets should be retested.

At the completion of this process, any other observers must be familiarised with the categories and coding system. Multiple observers should then perform a test session and conduct an inter-observer reliability test to ensure that all concerned are competent with the process. Days 3-5 of attendance should then be dedicated to observation.

8.5 Conclusions

In summary, this report suggests that adopting a formal approach to the collection of observational data on team and task performance from Army HQ will substantially contribute to our understanding and enhancement of military team processes. In particular, it provides an objective method of identifying existing team processes as well as the impact of digitised systems on performance. A strength of this approach is that it can be applied at any level of HQ (Bde to Coy), and at different intensities and tempos. It also provides indices of performance that can be correlated with other outcome measures, as well as implications for command support system design based on functional accounts of behaviour.

9. Acknowledgments

The authors wish to thank the personnel of 10/27 Regiment for their participation in data collection during Exercise Rhino Charge 2000. We would also like to acknowledge Major Chris Roe for his cooperation and assistance in providing access to the exercise. It proved to be a most valuable opportunity to test the preliminary assessment of the methodology. From LOD, DSTO, we would like to acknowledge Mr Fred Bowden for his important feedback during the writing process, and Mr Sam Huf and Mr Peter Williams for their valuable contribution during the exercise.

10. References

Altman, J (1974). Observational study of behavior. *Behaviour*, 49, 227-267.

Bakeman, R. (1978). Untangling streams of behavior: Sequential analysis of behavioural data. In G. P. Sackett (Ed.). *Observing Behavior, vol. 2, Data Collection and Analysis Methods* (pp. 63-78). Baltimore: University Park Press.

Bowden, F., Gaertner,. P & Williams, P. (2000). A Near Real-Time Tactical Land C4I Assessment Capability, Paper published in the *Proceedings of the Fifth International Conference on Simulation Technology and Training (SimTecT00)*, Sydney, Australia, February 2000, 291-296.

Bowers, C. A., Baker, D. P. & Salas, E. (1994). Measuring the importance of teamwork: The reliability and validity of job/task analysis indices for team-training design. *Military Psychology*, 6(4), 205-214.

Bowers, C., Thornton, C., Braun, C., Morgan, B. B., & Salas, E. (1998). Automation, task difficulty, and aircrew performance. *Military Psychology*, 10(4), 259-274.

Brannick, M. T., Prince, A., Prince, C. & Salas, E. (1995). The measurement of team processes. *Human Factors*, 37(3), 641-651.

Cannon-Bowers, J. A., & Salas, E. (1998). Team performance and training in complex environments: Recent findings from applied research. *Current Directions in Psychological Science*, 83-87.

Collyer, S. C. & Malecki, G. S. (1998). Tactical decision making under stress: History and overview. In J. A. Cannon-Bowers & E. Salas (Eds.). *Making decisions Under Stress: Implications for Individual and Team Training* (pp. 3-15). Washington: American Psychological Association.

Crockett,C. M. (1996). Data collection in the zoo setting: Emphasising behavior. In D. G. Kleiman, M. E. Allen, K. V. Thompson & S. Lumpkin (Eds.). *Wild mammals in Captivity: Principles and Techniques.* (pp. 545-565). Chicago: The University of Chicago Press.

Dunbar, R. I. M. (1976). Some aspects of research design and their implications for the observational study of behaviour. *Behaviour*, 58, 78-98.

Entin, E. E. & Serfaty, D. (1999). Adaptive team coordination. *Human Factors*, 41(2), 312-325).

Gregory, D. & Kelly, M. (1998). *Impact of Digitization on Command and Staff Training: Implications for the Design of Training Simulators.* DERA/CHS/MID/CR980188/1.1, Aug. 1998.

Hinde, R. A. (1973). On the design of checksheets. *Primates*, 14, 393-406.

Hollenbeck, A. R. (1978). Problems of reliability in observational research. In G. P. Sackett (Ed.). *Observing Behavior, vol. 2, Data Collection and Analysis Methods* (pp. 79-98). Baltimore: University Park Press.

Klein, G. (1993). *Naturalistic Decision Making: Implications for Design.* CSERIAC.

Leedom, D. K. (1999). *Thinking Inside or Outside of the Box: Impact of Digitisation on Battle Command.* US Army III Corps.

Lehner, P. N. (1979). *Handbook of Ethological methods.* New York: Garlands STMP).

Martin, P. & Bateson, P. (1993). *Measuring Behaviour: An Introductory Guide.* 2nd ed. Cambridge: Cambridge Universtiy Press.

Noldus, L. P. J. (1991). The Observer: A software system for collection and analysis of observational data. *Behaviour Research Methods, Instruments and Computers*, 23, 415-429.

McIntyre, R. M. & Salas, E. (1995). Measuring and managing for team performance: Emerging principles from complex environments. In R. Guzzo & E. Salas (Eds.), *Team Effectiveness and Decision Making in Organisations* (pp. 149-203). San Francisco: Jossey-Bass.

Orasanu, J. & Salas, E. (1993). Team decision making in complex environments. In G. A. Klein, J. Orasanu, R. Calderwood, & C. E. Zsambok (Eds.) (pp. 327-345). *Decision Making in Action: Models and methods.* New Jersey: Ablex Publishing Corporation.

Pascual, R. G. (1999). Tools for capturing and training shared understanding in teams. Paper published in the proceedings of *People in Control: An International Conference on Human Interfaces in Control Rooms, Cockpits and Command Centres*: 21-23 June, 1999, Conference Publication No. 463 © IEE 1999

Salas, E., Prince, C., Baker, D. P., & Shrestha, L. (1995). Situation awareness in team performance: Implications for measurement and training. *Human Factors*, 37(1), 123-136.

Serfaty, D., & Entin, E. E. (1997). Team adaptation and coordination training. In R. Flin, E. Salas, M. Strub, & L. Martin (Eds.). (pp. 170-184). *Decision Making Under Stress: Emerging Themes and Applications.* Ashgate.

Serfaty, D., Entin, E. E., & Deckert, J. C. (1994). Implicit coordination in command teams. In A. H. Lewis & I. S. Lewis (Eds.) (pp. 87-94). *Science of Command and Control: Part III: Coping with Change.* AFCEA Press.

Smith-Jentsch, K. A., Johnston, J. H. & Payne, S. C. (1998). Measuring team-related expertise in complex environments. In: J. A. Cannon-Bowers & E. Salas (Eds.) *Making Decisions under: Stress: Implications for Individual and Team Training* (pp. 61-87). Washington: American Psychological Association

Stout, R. J., Cannon-Bowers, J. A., Salas, E. & Milanovich, D. M. (1999). Planning, shared mental models, and coordinated performance: An empirical link is established. *Human Factors*, 41(7), 61-71.

Stout, R. J., Salas, E. & Carson, R. (1994). Individual task proficiency and team process behaviour: What is important for team functioning? *Military Psychology*, 6(3), 177-192).

Timberlake, W. (1998). Biological behaviorism. In: W. O'Donohue & R. Kitchener (Eds.), *Handbook of Behaviorism*. San Diego: Academic Press.

Thomas, A. R. (1999). *Naturalistic Decision making: The Effects of Direct and Indirect Management Structures and Uncertainty using Fire Chief.* The University of Adelaide: Unpublished Honours Thesis.

Vicente, K. J. (1999). *Cognitive Work Analysis: Toward Safe, Productive, and Healthy Computer-Based Work.* Mahwah: Lawrence Erlbaum Associates, Inc., Publishers.

Appendix A: Glossary

Event: The onset or the single defining instant of any behaviour; instantaneous behaviour; momentary behaviour

State: Behaviour with appreciable duration; behaviour at a given point in time

Duration: time spent in state

Transition Time: Time of onset or termination of behaviour; change from one state to another.

Frequency: number of occurrences – either state or event

Bout: Occurrence of a durational behaviours or sequences of behaviour – eg – a bout of work

Rate: Frequency per time/classification

Exhaustive: All-encompassing – subject recorded as doing something, even when "not active"

Mutually Exclusive: Non-overlapping categories

Appendix B: Data Collection Proformas

B.1. Objective Taskload Measurement Sheet ~ Draft

Time: **Date:** **Observer:** **HQ:** **Exercise:**

Insert Observed Behaviours

Time	Cognitive	Physical	Temporal	Frustration
2				
4				
6				
8				
10				
12				
14				
16				
18				
20				
22				
24				
26				
28				
30				

B.2. Team Behaviour Measurement Sheet ~ Draft

Time: Date:	Observer: HQ:		Exercise:										
	CELL		OPS Cell			LO		Search Cell		INT Cell			
INDIVIDUALS		Officer in Charge	Duty Officer	Duty Clerk	Signals Officer	LO 1	LO 2	Search Cell 1	Search Cell 2	Intel Officer	Duty man	2IC	Floater (rotation)
Assertiveness	Ask for clarification												
	Maintain position when challenged												
	Volunteer suggestion												
	Offer opinion on decision												
	Correct mistakes												
Mission Analysis/ Decision Making	Define tasks in terms of mission requirement												
	Identify short term plan												
	Identify long term plan												
	Critique plan												
	Gather information												
	Cross-check information												
	State contingencies/ alternatives												
	State consequences of actions												
	State implications of unplanned events												
	Allocate and monitor resources												
Adaptability/ Flexibility	Alter course of action												
	Assist other faced with problem												
	Redistribute workload												
	Reorganise team roles												
	Monitor other's behaviour												
Situation Awareness	Identify problem												
	Detect situation that requires corrective action.												
	Provide update of where team is in relation goals												
	Identify impediments to goal attainment												
	Provide information prior to request												
	Anticipate change in the situation												
	Anticipate need of other team member												
	Ask for clarification of tasks												
	Clarify roles (your job is to…)												
Leadership	Specify task to be assigned												
	Ask for input in plans/decision												
	Focus team attention on current task												
	Provide feedback to team												
	Explain to others what's required												
	Listens to concerns												
Communication	Request information												
	Volunteer information												
	Ignore request for information												
	Provide information when requested												
	Repeat vital information												
	Pass instructions/ give orders												
	Ask for repeat of what was said (couldn't hear)												
	Acknowledge communication												
	Ask for clarification of information												
	Verify information												
	Use standard terminology												
	Use non-standard terminology												
	General discussion of task issues												
	Asking for quiet/no chatter												
Morale	Banter												
	Sarcastic/belittling tone												
	Humorous tone												

DISTRIBUTION LIST

Towards a Research Methelodogy for Assessing Army Command Team Performance: A Preliminary Investigation

V Mills and C Stothard

AUSTRALIA

DEFENCE ORGANISATION

Task Sponsor
Director General C3I Development

S&T Program
Chief Defence Scientist
FAS Science Policy
AS Science Corporate Management
shared copy
Director General Science Policy Development
Counsellor Defence Science, London (Doc Data Sheet)
Counsellor Defence Science, Washington (Doc Data Sheet)
Scientific Adviser to MRDC Thailand (Doc Data Sheet)
Scientific Adviser Policy and Command
Navy Scientific Adviser (Doc Data Sheet and distribution list only)

Scientific Adviser - Army

Air Force Scientific Adviser
Director Trials

Aeronautical and Maritime Research Laboratory
Director

Electronics and Surveillance Research Laboratory
Director (Doc Data Sheet and distribution list only)

Chief of Land Operations Division
Research Leader Human Factors
Research Leader Land Systems
Fred Bowden
V Mills
C Stothard

DSTO Library and Archives
Library Fishermans Bend(Doc Data Sheet)
Library Maribyrnong(Doc Data Sheet)
Library Salisbury (1 copy)
Australian Archives (Doc Data Sheet)
Library, MOD, Pyrmont (Doc Data sheet only)
US Defense Technical Information Center, 2 copies
UK Defence Research Information Centre, 2 copies

Canada Defence Scientific Information Service, 1 copy
NZ Defence Information Centre, 1 copy
National Library of Australia, 1 copy

Capability Systems Staff
Director General Maritime Development (Doc Data Sheet only)
Director General Land Development
Director General Aerospace Development (Doc Data Sheet only)

Army
ABCA Standardisation Officer, Puckapunyal, (4 copies)
SO (Science), DJFHQ(L), MILPO Enoggera, Queensland 4051

Intelligence Program
DGSTA Defence Intelligence Organisation
Manager, Information Centre, Defence Intelligence Organisation

Corporate Support Program
Library Manager, DLS Canberra (Doc Data Sheet)

UNIVERSITIES AND COLLEGES
Australian Defence Force Academy
Library
Head of Aerospace and Mechanical Engineering
Serials Section (M list), Deakin University Library, Geelong, 3217
Hargrave Library, Monash University (Doc Data Sheet only)
Librarian, Flinders University

OTHER ORGANISATIONS
NASA (Canberra)
Ausinfo
State Library of South Australia
Parliamentary Library, South Australia

OUTSIDE AUSTRALIA

ABSTRACTING AND INFORMATION ORGANISATIONS
Library, Chemical Abstracts Reference Service
Engineering Societies Library, US
Materials Information, Cambridge Scientific Abstracts, US
Documents Librarian, The Center for Research Libraries, US

INFORMATION EXCHANGE AGREEMENT PARTNERS
Acquisitions Unit, Science Reference and Information Service, UK
Library - Exchange Desk, National Institute of Standards and Technology, US

SPARES (5 copies)

Total number of copies: 49

Page classification: UNCLASSIFIED

DEFENCE SCIENCE AND TECHNOLOGY ORGANISATION DOCUMENT CONTROL DATA	1. PRIVACY MARKING/CAVEAT (OF DOCUMENT)

2. TITLE	3. SECURITY CLASSIFICATION (FOR UNCLASSIFIED REPORTS THAT ARE LIMITED RELEASE USE (L) NEXT TO DOCUMENT CLASSIFICATION)
Towards a Research Methodology for Assessing Army Command Team Performance: A Preliminary Examination	Document (U) Title (U) Abstract (U)

4. AUTHOR(S)	5. CORPORATE AUTHOR
Vanessa Mills and Christina Stothard	Electronics and Surveillance Research Laboratory PO Box 1500 Salisbury SA 5108 Australia

6a. DSTO NUMBER	6b. AR NUMBER	6c. TYPE OF REPORT	7. DOCUMENT DATE
DSTO-TR-1034	AR-011-554	Technical Report	September 2000

8. FILE NUMBER	9. TASK NUMBER	10. TASK SPONSOR	11. NO. OF PAGES	12. NO. OF REFERENCES
D9505-19-96	981271	C3ID	39	29

13. URL on the World Wide Web	14. RELEASE AUTHORITY
http://www.dsto.defence.gov.au/corporate/reports/DSTO-TR-1034.pdf	Chief, Land Operations Division

15. SECONDARY RELEASE STATEMENT OF THIS DOCUMENT

Approved for public release

OVERSEAS ENQUIRIES OUTSIDE STATED LIMITATIONS SHOULD BE REFERRED THROUGH DOCUMENT EXCHANGE, PO BOX 1500, SALISBURY, SA 5108

16. DELIBERATE ANNOUNCEMENT

No Limitations

17. CASUAL ANNOUNCEMENT Yes

18. DEFTEST DESCRIPTORS

Team Performance, Teamwork, Group Dynamics, Decision Support Systems, Personnel Evaluation

19. ABSTRACT

This report presents a summary of observational methodologies that are being developed to collect behavioural data on team processes in an Army Headquarters (HQ). The report will describe this approach, and will present a sample of data that can be generated using these methods. The techniques are currently being applied to observations within the Australian Army to determine their usefulness, and to collect empirical data on the information flow among the team, the team dynamics, the task characteristics, and the overall workload. A strength of this approach is that it can be applied at any level of HQ, and at different intensities and tempos. It also provides indices of performance that can be correlated with other outcome measures, as well as implications for system design based on functional accounts of behaviour.

Page classification: UNCLASSIFIED